Data Collection Actvity **Name** ____________________

The Ball Goes Up, the Ball Comes Down

Introduction: The objective of this activity is to collect data from pushing a ball up a ramp and, with a motion detector placed at the top of the ramp, record the distance vs. time data of the ball as it moves up and then back down the ramp. We will then analyze the data by finding a model for the distance vs. time data, and a model for the velocity vs. time data.

The data we have collected and graphed is a distance vs. time scatterplot of the distance from the ball to the CBR. It appears to be "parabolic", so we will attempt to fit our data with a **quadratic function** in its **vertex form**:

$$y = a(x-h)^2 + k \quad \text{or, as a distance function } d(t),\ d(t) = a(t-h)^2 + k$$

1. Explain what the values of **h** and **k** in the equation represent with respect to our data. By tracing, on the scatterplot, you should be able to obtain values for **h** and **k**. Round these values to the nearest hundredth and record them.

It appears that **h** = ____________ and **k** = ____________

The values of **h** and **k** mean something with respect to the activity! Explain what the values of **h** and **k** represent with respect to the data collected. Be specific!

h represents ____________________

k represents ____________________

2. First, we are going to find the value of **a** for our equation by *trial and error*. Enter the **vertex form** of your equation using the **h** and **k** values above in **Y1** of your calculator along with an initial guess for the value of **a**. Experiment until you find a value of **a** that provides a good fit for the data.

a = ____________

3. Record your final function.

d(t) = ____________________

Note: Write your function in terms of time **t**, not interms of **x**!

4. Now let's find the value of **a** (again) using algebra. Pick another point (not close to the vertex) on your scatterplot. Substiute the **x** and **y** values of this point, along with the values of **h** and **k**, into the equation and solve for **a**. Show your work below.

a = ____________

Is this value of **a** close to the value for **a** that you found using trial and error? It should be!

5. It is also possible to express any **quadratic function** in the **general form**:

$$y = ax^2 + bx + c \quad \text{or} \quad d(t) = at^2 + bt + c$$

To determine the values of **b** and **c** (since **a** is identical to that found in part 2 or part 4 above), expand your equation in part 3, and collect like terms. Round all values to the nearest hundredth. Show this work below.

d(t) = ______________________________

6. To check your work, enter this general form of the quadratic function into **Y2** of your calculator, and see if it fits the data as well as your function in **Y1**. If not, find your mistake!

7. As another check, perform a **quadratic regression** on your data which will allow your calculator to find the "best-fitting" quadratic function (in general form) through the set of data. (This can be done by pressing the STAT key, go to CALC, and select 5:QuadReg.) Again, round all values to the nearest hundredth and record this equation below (in terms of **t**.).

d(t) = ______________________________

8. The "velocity" data of the ball is stored in L3. Change your scatterplot to see the velocity (L3) vs. time (L1).

Since the scatterplot of the velocity vs. time data appears to be **linear**, choose two points from the scatterplot that best represent the line, and find a linear function ($v(t) = m \cdot t + b$) that models the velocity of the ball at any time t. Show your work below, and write the function that models the data. (Round the values of m and b to two decimal places.)

v(t) = ____________________

When done, sketch the velocity function v(t) on the scatterplot to see how it fits. If it doesn't fit well, find your mistake!

9. Use your velocity function v(t) in #8 above to answer the following.

a. What was the velocity of the ball when we began collecting data? ____________________

b.. Where can we find this value (or a value close to this) in the distance function in #7?

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c. Use the velocity function to determine the time that the ball reached it's maximum height?

Hint: What is true about the ball the instant it is at its maximum height

t = ____________

d. Where did we see this value before in our answer to #3?

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